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ALTERATION OF LUNAR SOIL'S POLARIZING PROPERTIES BY THE ACTION OF SOLAR PROTONS

by

Audouin Dollfus
John E. Geake

[FRANCE]

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ALTERATION OF LUNAR SOIL'S POLARIMETRIC PROPERTIES BY THE ACTION OF SOLAR PROTONS*

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by Audouin Dollfus
& John E. Geake

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SUMMARY

The photometric and polarimetric characteristics of lunar soil can be modified by solar wind-produced proton bombardment. Some of the mineral matters in powdered state acquire under proton bombardment polarizing properties almost identical to those of lunar soil. author

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The solar light, reflected by lunar soil surface offers a certain partial polarization, of which the proportion varies with the phase angle, the brightness of the lunar region [1] and also the spectral domain [2]. The polarimetric examination of Moon's ashen light indicates, among other things, the depolarization provided by the lunar soil on the polarized light of terrestrial origin [3].

These properties are interpreted with the aid of measurements on mineral substances [3, 4]. Very specific criteria characterize then a powdery surface of which the grains of all dimensions are entangled in a complex fashion and are constituted of a very opaque material absorbing the light completely under a thickness of a few wavelengths [4, 5].

Volcanic ashes and certain crushed lavas into fine powdery state reproduce satisfactorily some of the polarizing properties of the lunar soil.

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* L'altération des propriétés polarimetriques du sol lunaire par l'action de protons solaires.

However, because various hypotheses on the nature of lunar soil recently envisioned, other materials retain the attention. One of us has already examined polarimetrically Indochina tektites, samples taken in breccia-like coating of the Arizona Meteor Crater, rhyolitic and basic obsidians, ignimbrites and numerous specimens of chondritic and achondritic meteorites.

These substances generally provide lighter powders than those of lunar soil and they polarize the light much more feebly. Their polarization curves, obtained by bringing the proportion of polarized light measured:

$$P = \frac{I_1 - I_2}{I_1 + I_2}$$

as a function of the phase angle V are nearly devoid of the negative branch which characterizes the lunar surface under phase angles $< 23^o$ (polarization at 90^o of the given direction by the vitrous reflection).

We will show, however, that these substances must not be rejected for the above reason as eventual constituents of the lunar soil.

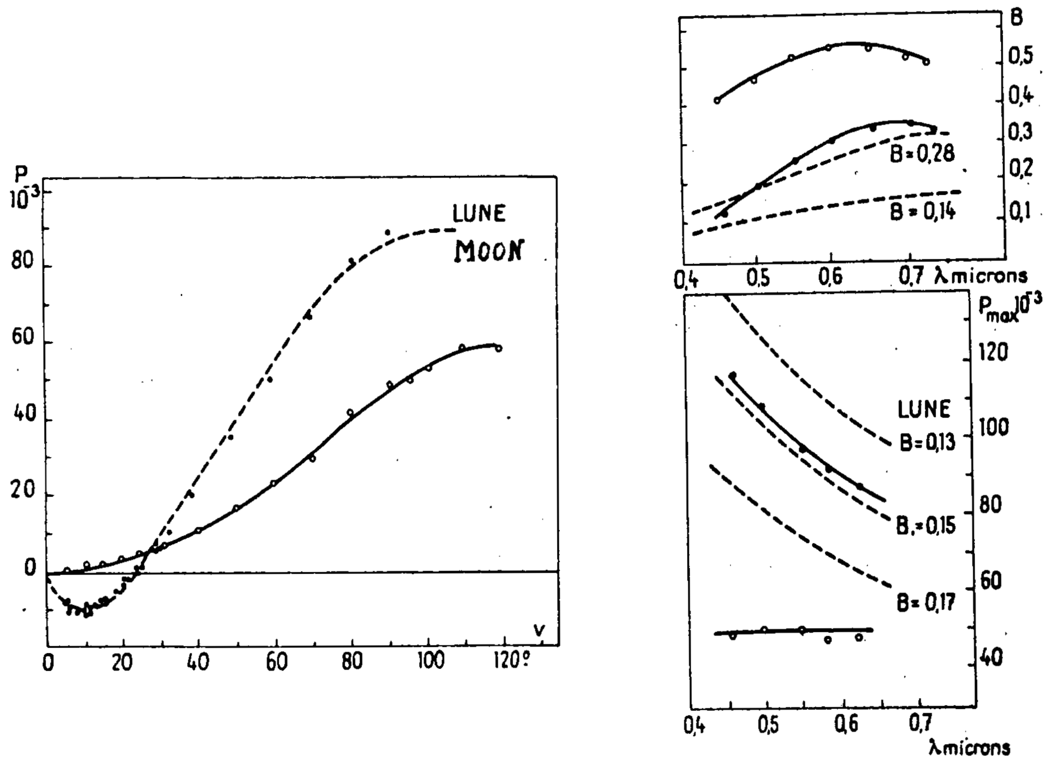
Indeed, the lunar surface is subject to bombardment by protons of solar origin. B. Hapke [6], G. Wehrner et al [8] and others have shown that a great number of powdered minerals darken when subject to an intense and prolonged bombardment by protons; their colors change and so does the polarization of their light. According to B. Hapke [7], the property of certain light powders then get to ressemble more particular those of the lunar surface.

In order to verify this with all the sensitivity of our polarimeters, we irradiated in July 1964 samples of pulverized meteorites under the proton bombardment device realized by one of us in Manchester [9]. The current density was of $2 \cdot 10^{-6}$ a/cm^2 under 60 keV.

A sample of achondritic meteorite with enstatite, fallen on 8 April 1932 at Khor-Temiki, reduced to powder, gave initially a polarization curve P (V), maximum polarizations $P_{max}(\lambda)$ and reflection powers $B(\lambda)$ for various wavelengths (shown by circles in the figures) quite different from those of lunar regions (shown by dashes).

After 8 hour of proton bombardment corresponding to the exposure

to solar wind during an only feeble cosmogonic period (of the order of 10^5 years, for example), the sample was strongly darkened.



Achondritic meteorite with enstatite (Khor Temiki)
in pulverized state.

---------- Curves measured on the Moon;
o Measurements on a pulverized sample of meteorite;
● Measurements on the sample blackened by a flux of protons during 8 hours under 60 keV and 2 10^{-6} a/cm^2.

The polarimetric and photometric measurements taken down are represented by dots in the Figure. The proportions of polarized light, measured in the yellow, become similar to those of lunar regions of reflecting power 0.145, under all the visual angles and with a precision of 1 / 1000. The variation of the maximum polarization with wavelength between 0.45 and 0.63 μ becomes equally similar to that of the Moon. The reflection power decreases in the blue, just as for the Moon, though the values still remain too high in a ratio of about 2.

In conclusion, the polarimetric study of lunar light has already permitted to identify the superficial physical structure of Moon's soil with a powder of absorbent grains; the absorbing character of grains may stem, at least partly, from the result of action by solar wind. In order to define more precisely the mineralogical composition by the polarimetric process, it will be necessary to take into considerations such alterations, that may modify the powders apparently too light, and give them the properties of the lunar soil.

*** THE END ***

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